What effect has folic acid fortification policy had on serum folate, plasma and/or red blood cell folate status of US and Canadian men, women, and children?

Conclusion

Strong and consistent evidence demonstrates serum, plasma and red blood cell (RBC) folate concentrations have increased in the United States and Canada, following mandatory folate fortification.

Grade: Strong

Overall strength of the available supporting evidence: Strong; Moderate; Limited; Expert Opinion Only; Grade not assignable For additional information regarding how to interpret grades, click here.

Evidence Summary Overview

Of the eleven studies reviewed, seven were from the US, two from Canada and one from the US/Mexico border counties. Given the ecological nature of mandatory fortification, it was impossible to conduct a controlled trial during this time.

Five of the US studies (Dietrich, 2005; Dowd, 2008; Ganji, 2006; Pfeiffer, 2007; Quinlivan, 2007) used National Health and Nutrition Examination Surveys (NHANES) data for analysis; therefore, these studies are nationally representative. All of the NHANES database studies showed an increase in serum and red blood cell (RBC) folate status and a reduction in low folate concentrations. The study of Dietrich et al (2005) compared men and women aged 20 and older (non-supplement users) from NHANES III (pre-fortification) and NHANES 1999 to 2000 (post-fortification). In comparison to pre-fortification values, both serum and RBC folate levels increased significantly. Mean serum levels more than doubled (136%), and mean RBC folate levels increased 57%. The prevalence of low RBC folate decreased significantly from 39% to 3.7% between the two surveys. The NHANES studies of Ganji et al (2006), Pfeiffer et al (2007) and Quinlivan et al (2007) added additional time periods, collectively covering 1999 to 2004. In all three studies, serum and RBC folate concentrations increased significantly in the first fortification time period and then declined slightly (5% to 13% and 6% to 9%, respectively) in most age groups between the first and second or third fortification periods. The decrease in folate concentrations observed following the initial folate fortification is small in comparison to the initial increase observed and is mostly likely a result of over-fortification during the initial fortification period.

The studies of Jacques et al, 1999, and Kalmbach et al, 2008 used the Framingham database to address this question. Both studies showed increases in folate concentrations and decreases in low folate concentrations following folate fortification. In the study of Kalmbach et al, 2008, supplement users were 2.28 (95% CI: 1.7 to 3.01) times more likely to have high circulating folate concentrations than were non-supplement users.

The two Canadian studies also showed increases in folate concentrations following mandatory fortification. Bar-Oz et al, 2008 examined women of childbearing years from four general practices and two hospitals in Ontario. They demonstrated that RBC folate levels rose significantly over the years, since fortification with fewer women of childbearing years at risk for low folate concentrations. Despite these improvements, a small but significant portion of women of childbearing years are still at risk for low folate concentrations following mandatory folate fortification.

Evidence Summary Paragraphs (11)

Bar-Oz et al, 2008 (neutral quality). This trend study examined the RBCs of women of childbearing age from four general practice laboratories and two hospitals in Ontario, Canada. The results showed that RBC folic acid levels have risen significantly over the years since fortification. Also, no significant (NS) difference in the medians between 2002 (1,207nmol per L) and 2004 (928nmol per L) and between 2004 (928nmol per L) and 2005 (910nmol per L). There was a significant difference in the medians between 2005 (910nmol per L) and 2006 (972nmol per L) (P=<0.01). Overall, there was a significant decrease in the population at risk (RBC folate below either 700 or 900nmol per L) (P<0.001) from 1998 to 2002. After 2002, this trend reversed with an increase in the proportion of women with levels below 900nmol per L from 24% in 2005 to 40% in 2006. After folic acid fortification, a considerable proportion of pregnant women are still at risk of having a baby with neural tube defects (NTD).

Dietrich et al, 2005 (neutral quality) This trend study measured changes in serum and erythrocyte folate status pre- and post-fortification. The data was taken from the NHANES III and NHANES 1999 to 2000 of healthy men and women 20 years old and older and non-supplement-using. In comparison to pre-fortification values, both serum and erythrocyte folate concentrations increased significantly (P<0.0001 for all age-sex groups) post-fortification. Mean serum folate increased more than double from NHANES III to NHANES 1999 to 2000 (136%), from 11.4nmol per L to 26.9nmol per L. Mean erythrocyte folate, a marker of long-term folate status, increased 57%, (from 375nmol per L to 590nmol per L) overall. Prevalence of inadequate serum folate concentrations (less than 7nmol per L) decreased significantly from 25.77% to 0.93% (P<0.0001). Prevalence of low erythrocyte folate (less than 305nmol per L) decreased significantly from 39.07% to 3.70% (P<0.0001) between the two surveys. Mean total folate intake increased 28%, from 275 ug per day to 351ug per day. In conclusion, mandatory folic acid fortification led to significant increases in both serum and erythrocyte folate concentrations; however, women of childbearing age may take supplements to reach levels associated with decreased risk of NTDs.

Dowd et al, 2008 (neutral quality), in this trend study examined the RBC of adults aged 25 years old or older. Data from NHANES survey were divided into two periods: 1) Pre-fortification [NHANES III (1991 to 1994)], and 2) Post-fortification (NHANES 1999 to 2000 and 2001 to 2002). The results showed that following fortification, the rate per 1,000 of low RBC folate status dropped from 95% CI: 528 (507, 549)nmol per L to 110 (91, 128) for the lowest income quartile, and from 374 (351, 396) to 42 (34 to 50) in the highest income quartile. The rate per 1,000 of low folate status in non-Hispanic blacks dropped from 95% CI: 647 (626, 667) to 171 (152, 190) following fortification, for Hispanics fell from 484(461, 507) to 58 (48, 67) and for non-Hispanics whites fell from 327 (310, 344) to 38 (32, 44).

Felkner et al, 2002 (neutral quality) This cross-sectional study examined the RBC of randomly selected women who delivered in a hospital or birthing center in 14 border counties from Texas-Mexico. They were controls in a population-based case-control NTD study from 1995 through 1999. Calculations showed that the median serum folate concentration increased modestly from 8.5ng per ml in 1996 to 12.4ng per ml in 1999 (46% higher). Also, the median RBC folate level increase from 272ng per ml in 1996 to 393ng per ml in 1999 (44% higher). The median RBC folate concentration in women, who were not prenatal vitamin users was 254ng per ml in 1996 and 378ng per ml in 1999 (49% increase). In conclusion, serum and RBC folate levels appear to have risen in this postpartum Texas-Mexico border population from 1996 through 1999. (Test for statistical difference is not mentioned.)

Ganji et al, 2006 (neutral quality) This trend study examined the serum and RBC folate of three NHANES survey periods: 1) NHANES III (1988 to 1994); 2) NHANES 1999 to 2000; and 3) NHANES 2001 to 2002. Serum and RBC folate concentrations were significantly higher and the prevalence of low serum and RBC folate concentrations were significantly lower in period 2 and 3 than in period 1, in all demographic groups of the US. Overall, mean serum folate concentrations were higher in period 2 (149.6%) and in period 3 (129.8%) than in period 1. From period 2 to 3, serum folate concentration significantly decline in men (7.3%, P=0.0012), in women (8.5%, P=0.0028), in non-Hispanic whites (NHW) (9.7%, P=0.0037), in those 18 years old (7.3%, P=0.0081), in those 31 to 50 years old (7.6%, P=0.0021), in those 51 to 70 years old (10.8%, P=0.0146) and in those with poverty income ratio (PIR) 1.0 (12.5%, P=0.0063) and $4.0 (9.9%, P=0.0068). When the data were adjusted for sex, age and race-ethnicity, there was a reduction of 10.4% in serum folate concentrations from period 2 to 3 (P<0.0002). Overall, mean RBC folate concentrations were 58.2% higher in period 2 and 56.5% higher in period 3 than in period 1. When the data were adjusted for sex, age and race-ethnicity, similar trends were present for RBC folate.

Jacques et al, 1999 (positive quality) This trend study assessed the effect of folic acid fortification on folate status. Plasma folate and total homocysteine concentrations were measured in a cohort of participants from the fifth and sixth examination Framingham study. The data were divided in two groups: 1) Baseline (fifth examination before fortification policy); 2) Follow-up (sixth examination after fortification policy); and 3) Control group (sixth examination before fortification policy began). Among the subjects who did not use vitamin supplements, the mean folate concentrations increased from the baseline to the follow-up visit, from 4.6 to 10.0ng per ml (11 to 23nmol per L) ($P<0.001$), increasing by 117% after fortification. The prevalence of low folate concentrations decreased from 22.0% to 1.7% ($P< 0.001$), decreasing by 92% [less than 3ng per ml (7nmol per L)]. In the control group, there were no statistically significant changes in concentrations of folate or homocysteine. The fortification of enriched grain products with folic acid was associated with a substantial improvement in folate status in a population of middle-aged and older adults.

Kalmbach et al, 2008 (positive quality) This cross-sectional study assessed the effect of folic acid fortification implementation on total plasma folate, circulation concentration of folic acid and 5-methyltetrahydrofolate (5MeTHF) in the Framingham Offspring Cohort. Among nonsupplement users, median circulating concentrations of folic acid increased after fortification (from 0.25 to 0.50nmol per L, $P<0.001$). The prevalence of detectable circulating folic acid was 55% before and 74.7% after fortification ($P<0.001$). The prevalence of high circulating folic acid was 9.4% before and 19.1% after fortification ($P=0.002$). Plasma folate concentrations were 91% higher after fortification ($P<0.001$) and 5MeTHF concentrations were 92% higher after fortification ($P<0.001$). Among B-vitamin supplements users, median circulating concentrations of folic acid increased after fortification from 0.54 to 0.68 ($P=0.001$). The prevalence of detectable circulating folic acid was 72.5% before fortification and 80.7% after fortification ($P=0.13$). The prevalence of high circulating folic acid increased from 15.9% to 24.3% after fortification ($P=0.02$). Total plasma folate concentration was 29.9% higher after fortification ($P<0.001$) and 5MeTHF concentrations were 28.7% higher ($P<0.001$) after fortification. A trend was observed for an increased prevalence of high circulating folic acid as the total folate intake increased ($P<0.001$). After adjusted for age, sex, vitamin intakes and total energy intake, folic acid intake, total folate intake, use of B-vitamin supplements and total plasma folate were the only significant determinants identified. Supplements users were 2.28 (95% CI: 1.7, 3.01) times more likely to have high circulating folic acid than were non-supplement users.

Pfeiffer et al, 2007 (positive quality) This trend study evaluated data from participants in the pre-fortification NHANES III (1988 to 1994), and participants in three post-fortification NHANES periods (covering 1999 to 2004). Measurements were comparing for serum folate for 1988 to 1994 and 1999 to 2004, vitamin B_{12} for 1991 to 1994 and 1999 to 2004, and RBC folate for 1988 to 1994 and 1999 to 2004. Serum and RBC folate concentrations increased substantially (by 119% to 161 % and 44% to 64%, respectively) in each age group in the first post-fortification survey period and then declined slightly (by 5% to 13% and 6% to 9%, respectively) in most age groups between the first and third post-fortification survey periods. Serum vitamin B_{12} concentrations did not change appreciably. Prevalence estimates of low serum and RBC folate concentration declined in women of childbearing age from before to after fortification (from 31% to less than 1% and from 38% to 5%, respectively) but remained unchanged thereafter. Prevalence estimates of high serum folate concentrations increased in children and older persons from before to after fortification (from 5% to 42% and from 7% to 38%, respectively) but decreased later after fortification. The authors concluded that decrease in folate concentrations observed longer after fortification is small compared with the increased soon after the introduction of fortification.

Quinlivan et al, 2007 (neutral quality), in this trend study used NHANES data to quantify changes in folate intake after folic acid fortification and estimated the effect on NTD occurrence. Three waves of NHANES data were divided in two periods: Pre-fortification (1988 to 1994) and post-fortification (1999 to 2000 and 2001 to 2004). Red blood cell and serum folate concentrations increased between 1988 to 1994 and 1999 to 2000, and then they decreased each year from 1999 to 2000 to 2003 to 2004. Between 1988 to 1994 and 1999 to 2000, the percentage increase in serum and RBC folate concentration was smallest in the women with the highest folate status. Median folate consumption of the study population increased by 529µg dietary folate equivalent (DFE) per day between before fortification and after fortification; then decreased by 135µg DFE per day between 1999 to 2000 and 2003 to 2004. The overall decrease in folate consumption was primarily due to changes in subjects with the highest folate status. Total folate consumption increased in the year after mandatory fortification. However, by 2003 to 2004, total folate consumed by subjects in the 90th percentile had decreased to 1,249µg DFE per day.

Ray et al, 2002 (neutral quality), This cross-sectional study examined the changes in rates of serum folate, RBC folate and vitamin B_{12} insufficiency among Canadian adults after the mandatory folic acid food fortification program was implemented. Data from 8,884 individuals who underwent evaluation were evaluated, organized on the following periods: 1) Period 1 (April 1, 1997 to July 31, 1998); 2) Period 2 (August 1, 1998 to January 30, 1999); and 3) Period 3 (February 1, 1999 to March 31, 2000). The prevalence of serum folate insufficiency (less than 3.4nmol per L) fell from 0.52% in period 1 to 0.22% in period 3 [prevalence ratio (RR) 0.41%, 95% CI: 0.18, 0.93]. The prevalence of RBC folate insufficiency (less than 215nmol per L) declined from 1.78% during period 1 to 0.41%in period 3 (RR 0.23, 95% CI: 0.14 to 0.40). No significant difference was observed between periods in the prevalence of B_{12} insufficiency below 120nmol per L (3.93% vs. 3.11%, respectively; RR 0.79, 95% CI: 0.62, 1.01).

Shuaibi et al, 2008 (negative quality) In this cross-sectional study of 95 women, the University of Manitoba assessed descriptive statistics for serum and RBC folate and total homocysteine. Also, assessed total folate intake (from natural food folate, folic acid added to food and folic acid supplements) and used T-tests to assess differences in folate intake between supplement users and non-users ($P<0.05$). The intake of natural food folate, expressed as micrograms, was 1.6 times more than the total folic acid from food and supplements intake expressed as micrograms, and almost the same when expressed as Dietary Folate Equivalents (DFEs). The total intakes for folate were significantly higher for supplement users compared to supplement non-users. The mean± SD, median and the range (10th and 90th percentile) for serum folate were, respectively, 14.6±3.5, 14.1 and 10.0 to 19.3ng per ml (33.0±7.9, 32.0 and 22.6 to 43.8nmol per L); for RBC folate, the values were 312.0±137.2, 286.8 and 180.5 to 462.9ng per ml

(707±311, 650 and 409 to 1,049nmol per L), respectively. Also, no women were folate deficient and 14% reached RBC folate higher than 400ug per day. Finally, intakes of folic acid from fortified foods are within the level originally predicted for the fortification efforts but only 17% of participants met the special recommendation for women of childbearing age (400ug folic acid daily from supplements, fortified foods or both in addition to consuming food folate from diet). This data suggest that women of childbearing age are increasing RBC folate status but it may not be sufficient to achieve values associated with reduction of NTD risk.

View table in new window

Author, Year, Study Design, Class, Rating	**Population/Sample Description**	**Measurements or Intervention**	**Significant Outcomes**	
Bar-Oz B, Koren G et al, 2008 Study Design: Trend study Class: D Rating:	Data from women of childbearing age from four general practice laboratories and two hospitals in Ontario were divided in three periods: 1) 1995 to 1997 (pre-fortification) 2) 1998 (start of fortification) 3) 2000 to 2006 (post-fortification).	RBC folate.	NS difference in RBC folate medians between 2002 (1,207nmol per L) and 2004 (928nmol per L). NS difference in the medians between 2004 (928nmol per L) and 2005 (910nmol per L). Significant difference in the medians between 2005 (910nmol per L) and 2006 (972nmol per L) $P \leq 0.01$). Significant ↓ in the population at risk (RBC folate <700 or 900nmol per L) ($P<0.001$) from 1998 to 2002. After 2002, this trend reversed with an ↑ in the proportion of women with levels <900nmol per L from 24% in 2005 to 40% in 2006.	

Dietrich M, Brown C et al, 2005 Study Design: Trend study Class: D Rating:	N=9,919 from NHANES III and 2,121 from NHANES 1999 to 2000 Age: ≥20 years.	Serum folate concentrations. Erythrocyte folate concentrations (marker of long-term folate status). Total dietary folate intake. Dietary folate sources.	In comparison to pre-fortification values, both serum and erythrocyte folate concentrations ↑ significantly ($P<0.0001$ for all age-sex groups) post-fortification. Mean serum folate ↑ from NHANES III to NHANES 1999 to 2000 (136%), from 11.4nmol per L to 26.9nmol per L. Mean erythrocyte folate ↑ 57% (from 375nmol per L to 590nmol per L). Prevalence of: Inadequate serum folate concentrations (<7nmol per L) ↓ significantly from 25.77% to 0.93% ($P<0.0001$). Low erythrocyte folate (<305nmol per L) ↓ significantly from 39.07% to 3.70% ($P<0.0001$).	
Dowd JB and Aiello AE, 2008 Study Design: Trend study Class: D Rating:	Three waves of NHANES were divided into two periods: 1) Pre-fortification [NHANES III (1991 to 1994)] 2) Post-fortification (NHANES 1999 to 2000 and 2001 to 2002). Age: ≥25 years.	RBC folate.	Following fortification, the rate per 1,000 (number of cases) of low RBC folate status (<362.6nmol): ↓ from 528 (95% CI: 507, 549) to 110 (95% CI: 91,128) for the lowest income quartile ↓ from 374 (95% CI: 351, 396) to 42 (95% CI: 34 to 50) in the highest income quartile.	

			Following fortification, the rate per 1,000 of low folate status: ↓ from 647 (95% CI: 626, 667) to 171 (95% CI: 152, 190) in non-Hispanic blacks ↓ from 484 (95% CI: 461, 507) to 58 (95% CI: 48, 67) in Hispanics ↓ from 327 (95% CI: 310, 344) to 38 (95% CI: 32, 44) in non-Hispanics whites.	
Felkner M, Suarez L et al, 2002 Study Design: Cross-sectional study Class: D Rating:	Data from a population-based case-control NTD study done in 14 border counties of Texas-Mexico, from 1995 through 1999. N=93 women (51 were for 1996, 27 for 1997, 44 for 1998 and 48 for 1999) randomly selected from the control group.	RBC folate, mean and median.	About half of the women were born in Mexico; ~half had annual family incomes <$15,000 and <12 years of education. Median serum folate concentration ↑ modestly from 8.5ng per ml in 1996 to 12.4ng per ml in 1999 (46% higher). Median RBC folate level ↑ from 272ng per ml in 1996 to 393ng per ml in 1999 (44% ↑). Median RBC folate concentration in women without prenatal vitamin users was 254ng per ml in 1996 and 378ng per ml in 1999 (49% ↑).	
Ganji V and Kafai MR, 2006 Study Design: Trend study	Data were measured at three periods: 1) NHANES III 1988 to 1994 2) NHANES 1999 to 2000	Serum, RBC folate. Circulation total homocysteine concentrations	Overall, mean serum folate concentrations in period 1, 2 and 3 were 12.1±0.3, 30.2±0.7 and 27.8±0.5nmol per L,	

Class: D Rating:	3) NHANES 2001 to 2002.	concentrations.	respectively. When data were adjusted for sex, age and race-ethnicity, there was a ↓ of 10.4% in serum folate concentrations from period 2 to 3 (P<0.0002). Overall, for all mean RBC folate concentrations in period 1, 2 and 3, 391±5.4, 318±11.7 and 611±9.3nmol per L, respectively. When data were adjusted for sex, age and race-ethnicity, similar trends were present for RBC folate.
Jacques PF, Selhub J et al, 1999 Study Design: Trend study. Class: D Rating:	Data from the Framingham Offspring Cohort were divided in three groups: 1) Baseline (fifth examination, pre-fortification) 2) Control group [sixth examination occurred before fortification began (January 1995 to September 1996)] 3) Study group (sixth examination, post-fortification). Data were examined for those who used vitamin supplements and those who did not.	Plasma homocysteine. Folate. Vitamin B_{12}. Pyridoxal 5'-phosphate (active, circulating form of vitamin B_6). Dietary intake of folate assessed with a FFQ.	For subjects in the study group, not using supplements, the mean folate concentrations ↑ from 4.6 to 10.0ng per ml (11 to 23nmol per L) (P<0.001) from baseline. The prevalence of low folate concentrations [<3ng per ml (7nmol per liter)] ↓ from 22.0% to 1.7% (P<0.001). In the control group, NS Δ in concentrations of folate or homocysteine. Study and control groups, who used B-vitamin supplements, significantly ↑ plasma folate concentrations from baseline to

			follow-up. ↑ 62% in the study group (P<0.001) and 24% control group (P<0.001).	
Kalmbach RD, Choumenkovitch SF et al, 2008 Study Design: Cross-sectional study (data from a longitudinal study) Class: D Rating:	Data from the Offspring cohort of the Framingham Heart Study was divided in four groups: *Not exposed to fortification:* 1) N=705 non-supplement users 2) N=398 supplement users. *Exposed to fortification:* 3) N=355 non-supplement users 4) N=245 supplement users.	Plasma folic acid (residual folic acid is a minor constituent of plasma folate that is not always detectable). Folic acid. 5MeTHF concentrations. Folate activity. Dietary intake assessed by FFQ.	Total plasma folate for no B-vitamin supplements users was 32.4ug per day before fortification and 241.4ug per day after fortification. For vitamin supplements users, the total plasma folate, before and after fortification, was 399.4 and 601.4ug per day, respectively.	
Pfeiffer CM, Johnson CL et al, 2007 Study Design: Trend study Class: C Rating:	Participants in the pre-fortification NHANES III (1988 to 1994) and participants in three post-fortification NHANES periods (covering 1999 to 2004).	Folate for 1988 to 1994 and 1999 to 2004. Vitamin B_{12} for 1991 to 1994 and 1999 to 2004. RBC folate for 1988 to 1994 and 1999 to 2004.	Serum and RBC folate concentrations ↑ substantially (by 119% to 161% and 44% to 64%, respectively) in each age group in the first post-fortification survey period and then ↓ (by 5% to 13% and 6% to 9%, respectively) in most age groups between the first and third post-fortification survey periods. Serum vitamin B_{12} concentrations did not Δ. Prevalence of RBC folate concentration ↓	

			significantly in women of childbearing age from before to after fortification (from 38% to 5%), but no Δ thereafter.	
Quinlivan E and Gregory J, 2007 Study Design: Trend study Class: D Rating:	Three waves of NHANES data were divided into two periods: 1) Pre-fortification (1988 to 1994) 2) Post-fortification (1999 to 2000 and 2001 to 2004).	Serum and RBC folate concentrations. Linear relationship between Δ in serum or plasma folate concentration and daily folate equivalents was determined.	RBC folate and serum folate concentrations ↑ between 1988 to 1994 and 1999 to 2000 and then ↓ each year from 1999 to 2000 to 2003 to 2004. Values for the 90th percentile of RBC concentration were: • 296ng per ml in 1988 to 1994 • 409ng per ml in 1999 to 2000 • 395ng per ml in 2001 to 2002 • 367ng per ml in 2003 to 2004.	
Ray JG, Vermeulen MJ et al, 2002 Study Design: Cross-sectional study Class: D Rating:	Data from 8,884 individuals who underwent evaluation of serum folate, red cell folate and serum vitamin B_{12} between: 1) Period 1 (April 1, 1997 to July 31, 1998) 2) Period 2 (August 1, 1998 to January 30, 1999) 3) Period 3 (February 1, 1999 to March 31, 2000).	All consecutive, concomitant and non-redundant: • Serum folate • RBC folate • B_{12}.	Prevalence of serum folate insufficiency (<3.4nmol per L) ↓ from 0.52% in period 1 to 0.22% in period 3 [prevalence ratio (RR) 0.41%, 95% CI: 0.18, 0.93]. Prevalence of RBC folate insufficiency (<215nmol per L) ↓ from 1.78% during period 1 to 0.41% in period 3 (RR 0.23, 95% CI: 0.14 to 0.40). NS difference observed between periods in the	

			prevalence of B_{12} insufficiency <120pmol per L (3.93% vs. 3.11%, respectively; RR 0.79, 95% CI: 0.62,1.01).	
Shuaibi A, House J et al, 2008 Study Design: Cross-sectional Class: D Rating:	N=95 healthy and non-pregnant college students were recruited from the University of Manitoba. Age: 18 to 25 years.	RBC folate. Dietary folate from natural food folate. Folic acid added to food. Folic acid supplements. Supplemental folate in the post-folic acid fortification era.	No women were folate deficient. 14% reached RBC folate >400ug per day. Mean serum folate concentration for all participants = 14.6ng per ml (33.1nmol per L) and for RBC folate concentration = 311.9ng per ml (706.7nmol per L). Mean dietary intake of folic acid = 96±64ug per day. Supplemental folic acid intake = 94±189ug per day. Natural folate was 314±134ug per day and total dietary intake measured as DFEs = 646±368ug per day.	

Research Design and Implementation Rating Summary
For a summary of the Research Design and Implementation Rating results, click here.

Worksheets

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